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FISHERIES

Northwest
Fisheries
Science Center

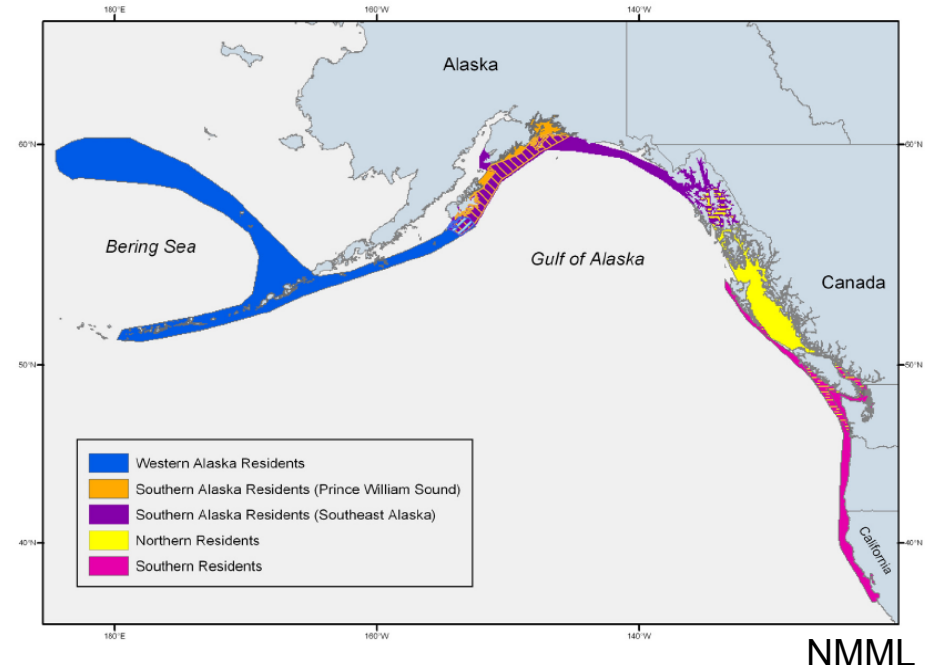
Science to support recovery of southern resident killer whales

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Center, Conservation Biology Division

West Coast Marine Mammal Program Review
July, 2015

Biological background

- “Residents” one of several N. Pacific ecotypes
- Fish eating, esp. salmon
- Matrilineal social structure w/o dispersal
- Southern residents
 - Southern most distribution
 - 3 pods – J, K, L
 - ~80 whales



Southern Residents: ESA listing history

- 2001: Petitioned for listing by Center for Biological Diversity and others
- 2002: NMFS found listing not warranted due to Southern Residents not being a DPS
- 2002: CBD sued NMFS over decision
- 2003: Court remanded matter back to NMFS
- 2005: Listed as endangered
- 2014: Listing re-affirmed in response to delisting petition



Science and management programs represent the work of many people, both NOAA and contractors/ collaborators

- NWFSC, SWFSC, AKFSC, NWR, SWR
- DFO Canada
- Center for Whale Research
- Cascadia Research
- University of Washington
- The Whale Museum
- Orca Network
- Salish Sea Hydrophone Network
- Education/Outreach Partners

How do we set science and management priorities?

- Strategic, pro-active
 - NOAA/NMFS strategic plans
 - Recovery Plans
 - NWFSC research planning
 - Driven by science gaps and long-term monitoring needs
 - Annual NWR/NWFSC meetings
- Short-term, responsive
 - Research and analysis to support specific decisions
 - Driven by incoming ESA/MMPA management actions (petitions, section 7)
 - As needed NWR/NWFSC meetings
- Southern Resident killer whales
 - Multiple workshops 2003- 2006, 2011, 2015 = development of long-term research plan
 - Recovery Plan and 5-year Review priorities
 - Analysis of specific actions (section 7 consultations)
 - Fisheries, alternative ocean energy, proposed regulations
 - Support response to petitions



Management and science priorities

Management Priorities / science

- **Status reviews**
 - Demography, genetics, distinct population segment determinations
- **Prey-** Section 7 consultations on actions that impact Chinook salmon
 - Diet studies, prey requirements, viability modeling
- **Vessel/sound-** Section 7 consultations on in-water construction, marinas, terminals and evaluation of existing regulations
 - Behavior studies, acoustic responses, cost of responses
- **Health -** Section 7 consultations on discharge permits, dredging, standards informed by health status, contaminant levels, and impact thresholds for marine mammals
 - Measure condition, contaminants in whales and prey, bacterial baseline
- **Critical habitat designation-** Coastal distribution and habitat use
 - Satellite tagging, passive acoustics, prey distribution, modeling

Demography and current status

Long term photo-ID datasets

- Multiple populations in NE Pacific
- Long time series
 - 30-40 years
- Individual IDs
 - Mark-recapture
- Can correlate with other populations and prey
- Small sample sizes
 - Especially SRKW
 - High uncertainty
- Imperfect detection for some populations
- Cause of deaths almost always unknown
- Some births are missed

Data sources: Center for Whale Research
CDFO, NMML, NGOS

SRKW most heavily impacted 1962-1977



- 47-48 whales removed
- Nearly all were juveniles
- 25% had bullet wounds
 - Impacts pre-dated captures
- Cohorts missing
 - No births 1967-1970
- Overall population size reduced to 67 in 1971 (NMFS 2008)
 - Skewed age distribution

Olesiuk et al. 1990, Hoyt et al. 1990, Bigg & Wolman 1976, CWR (2004), 2008 Status Review



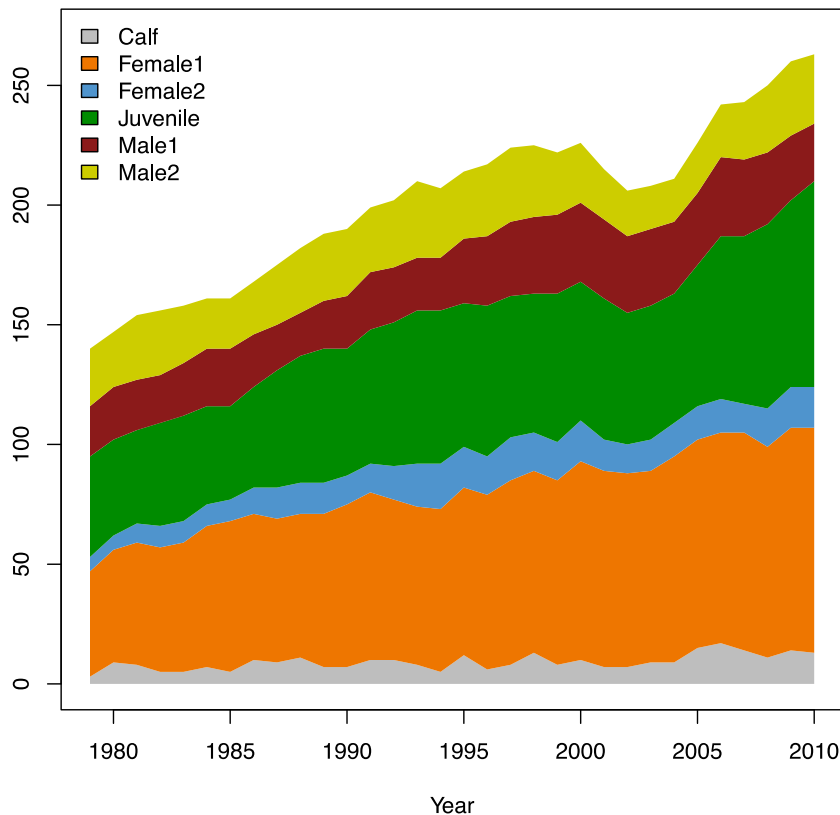
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NRKW males ~ constant

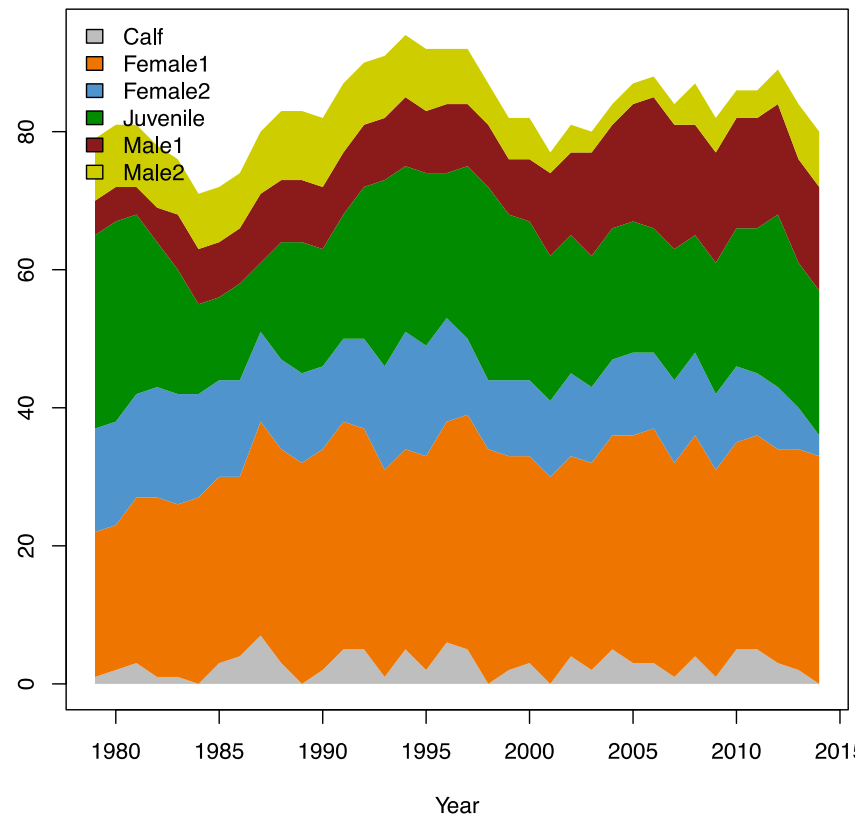
SRKW reproductive females ~ constant

SRKW post-reproductive females decline

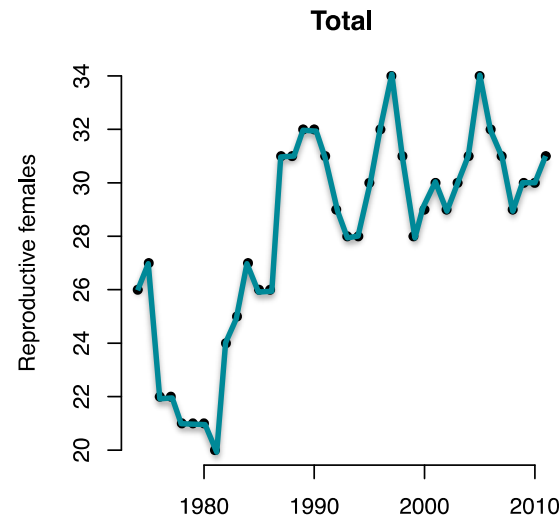
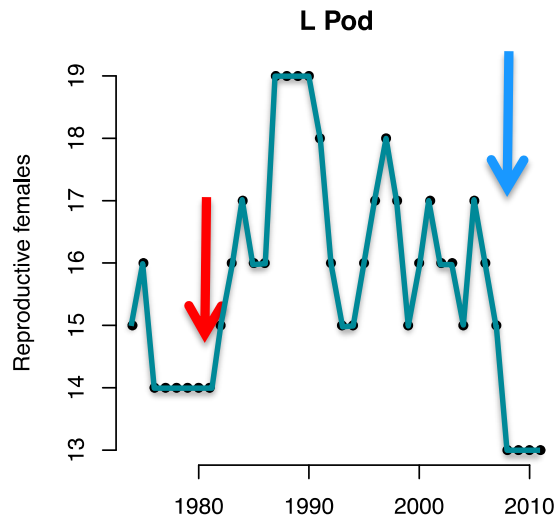
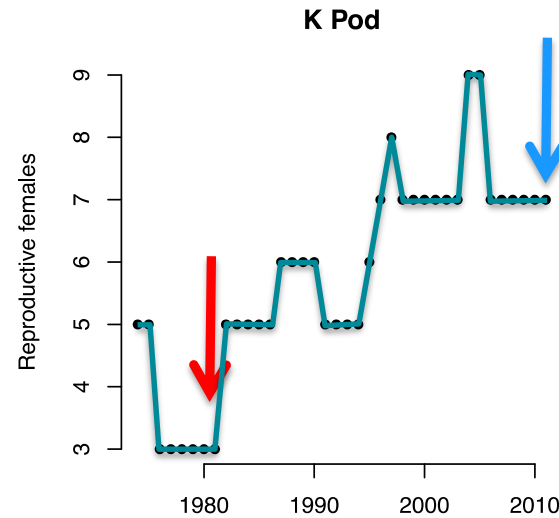
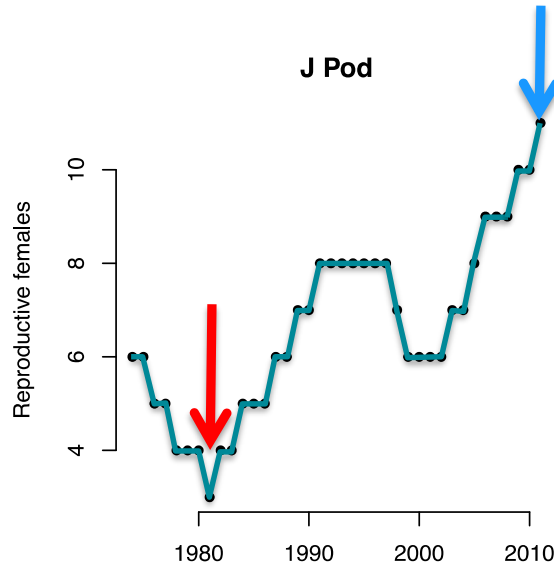
NRKW 1979-2010



SRKW 1979-2014



Reproduction shifting from L to J pod

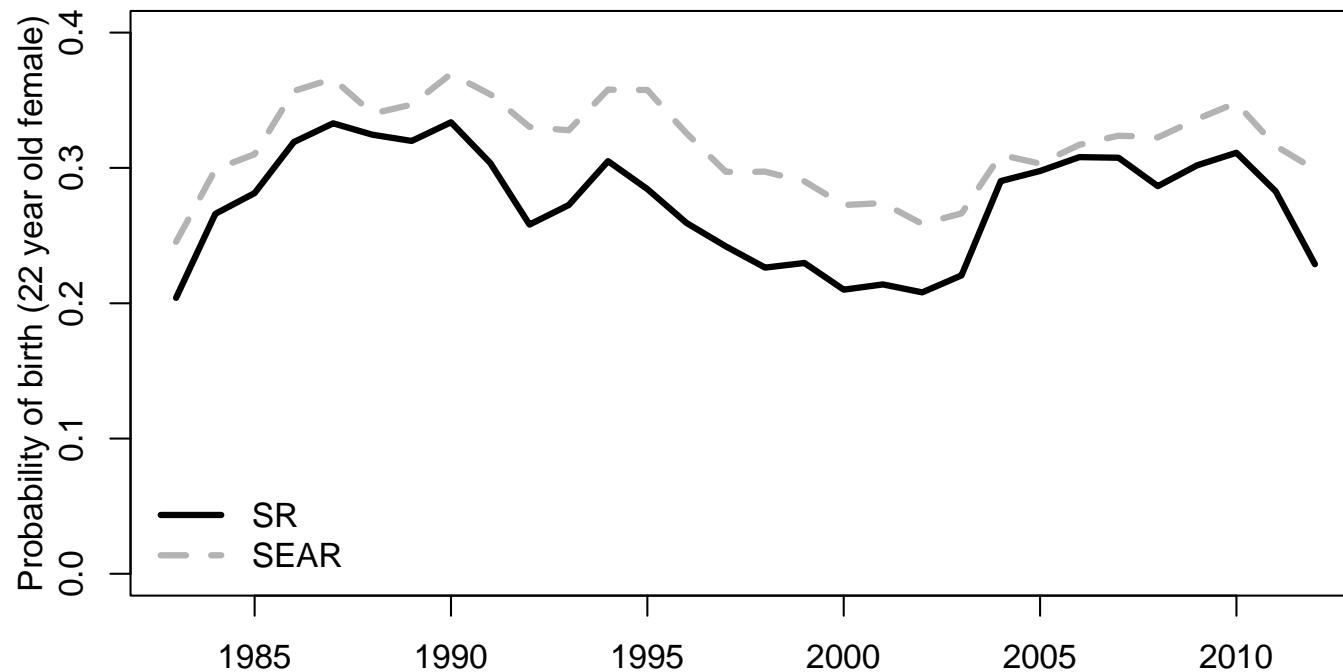


**Senescence+
lack of recruits**

**Total # reproductive
females basically
Constant since 1985**

SRKW are synchronous with other populations

- NRKW: Ford et al. 2010: correlated mortality
- SRKW demographic rates are also very correlated with AF/AG pods (Ward, Dahlheim et al in prep)

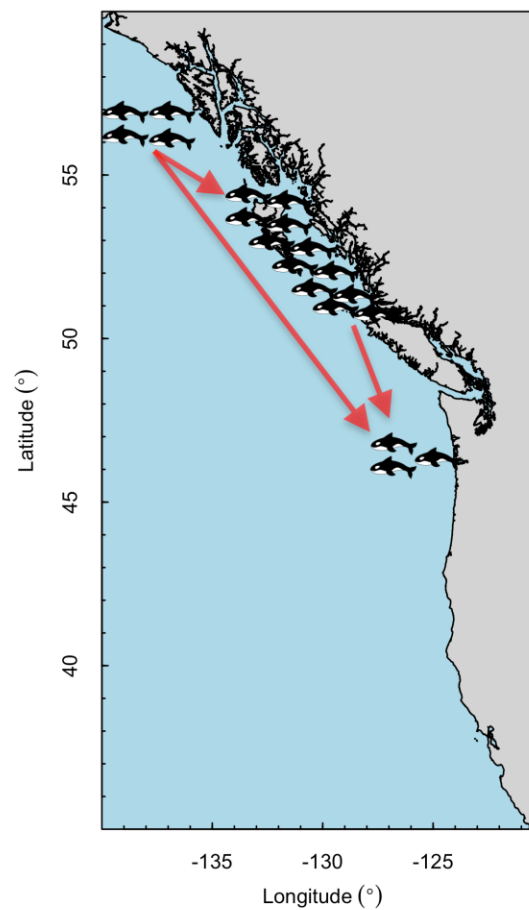


Across NE Pacific, fish-eating KWs doing very well

- NRKW and SEAK populations have doubled
- Asymmetric competition

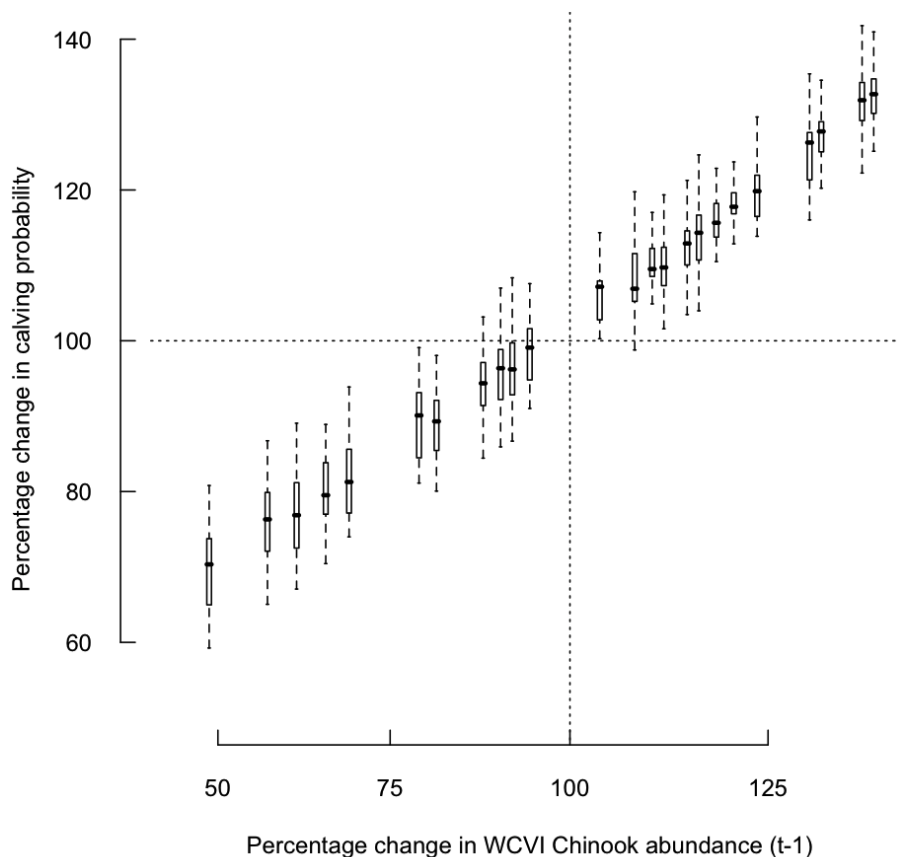
	SEAK	NRKW	SRKW
1974	--	123	67
1984	39	153	74
1994	61	205	96
2004	100	220	87
2014	121	257	78

- Salmon given credit for their success (Matkin 2014)
- Majority of SEAK Chinook in fisheries originate from CA/OR/WA (ADFG GSI work)

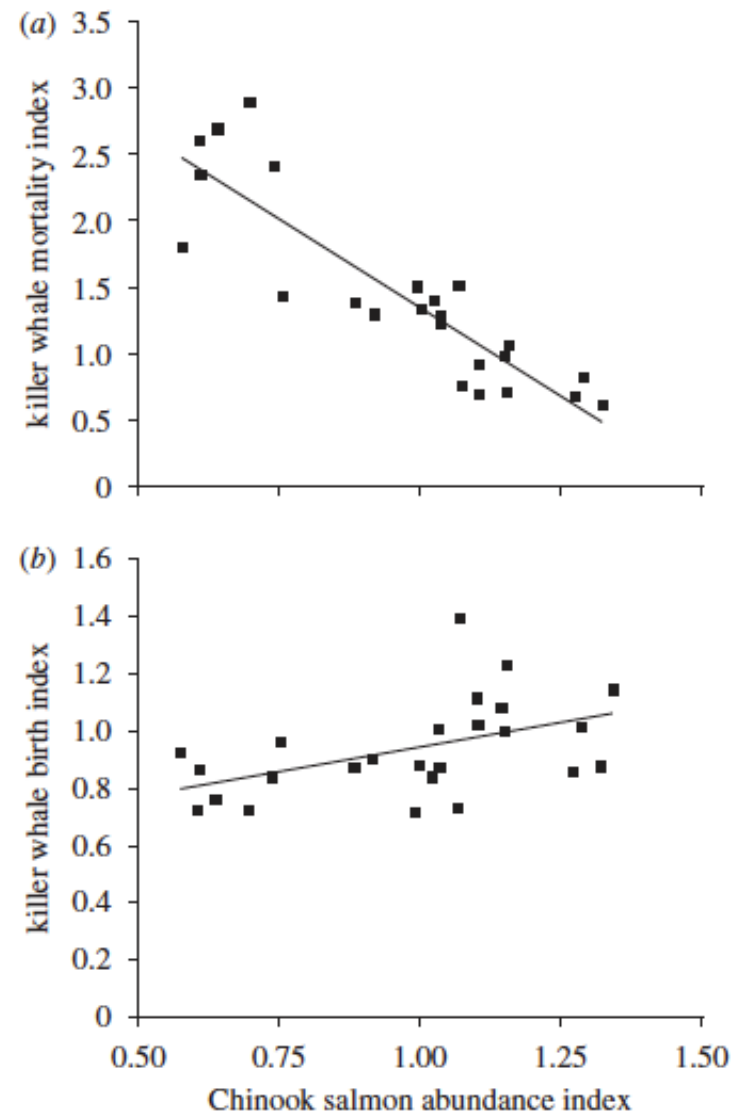


- SEAK >> NRKW >> SRKW

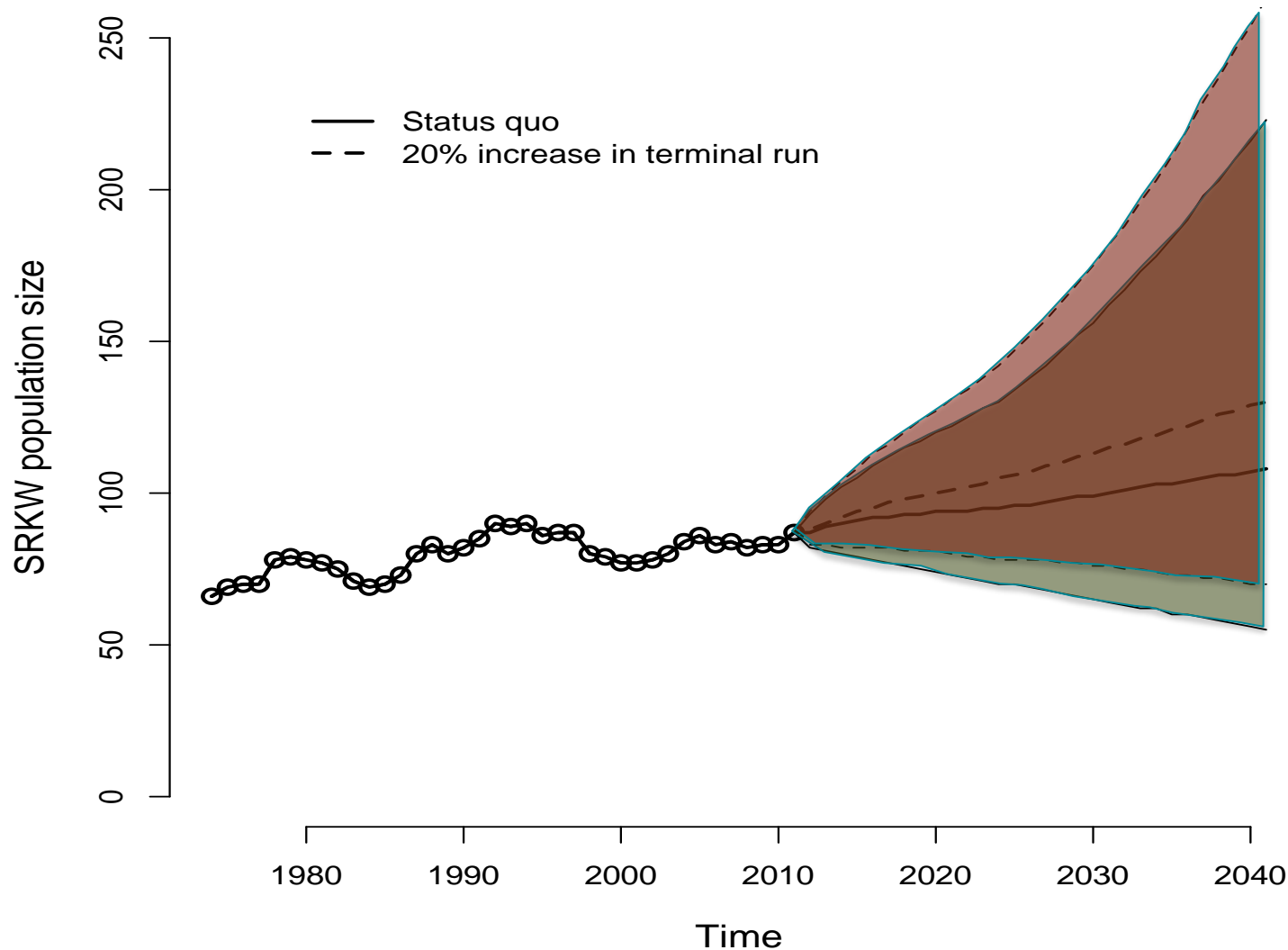
Whale survival and birth rate is correlated with Chinook abundance



Ward et al. (2009)



Projected population size at different salmon abundance



Modeling interactions between killer whales, salmon and pinnidpeds

- Hilborn et al. (2012)

Key Point:

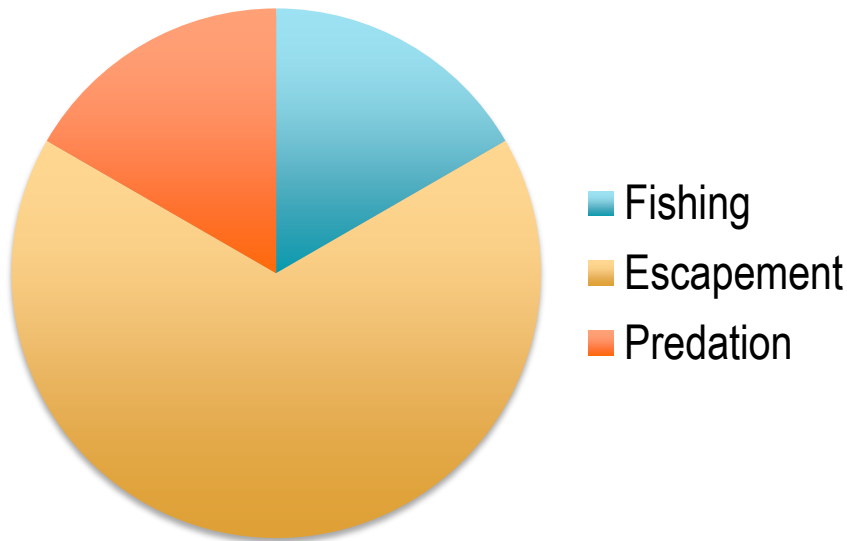
The Panel is not confident that understanding of the interaction between Chinook salmon fisheries, other predators and SRKW vital rates, is sufficient to expect the model predictions of increased SRKWs to be accurate.

The Panel expects the model predictions to overestimate the impact of reductions in Chinook salmon catch on SRKW.

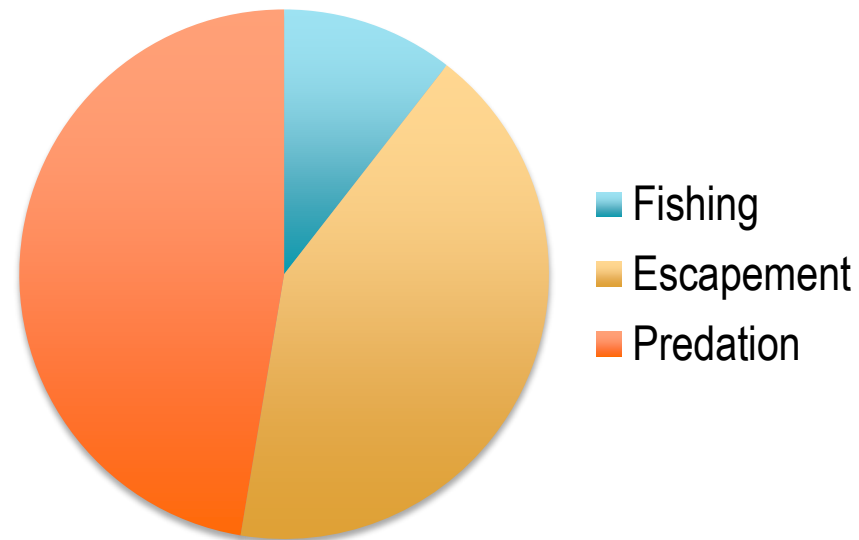
- Fishing closures unlikely to have detectable impact on SRKW
- Fishing closures may benefit other marine mammals
 - Other resident killer whales (NRKW, SEAK)
 - Other species (harbor seals, SSLs, CA sea lions)

Accounting for salmon consumption by predators

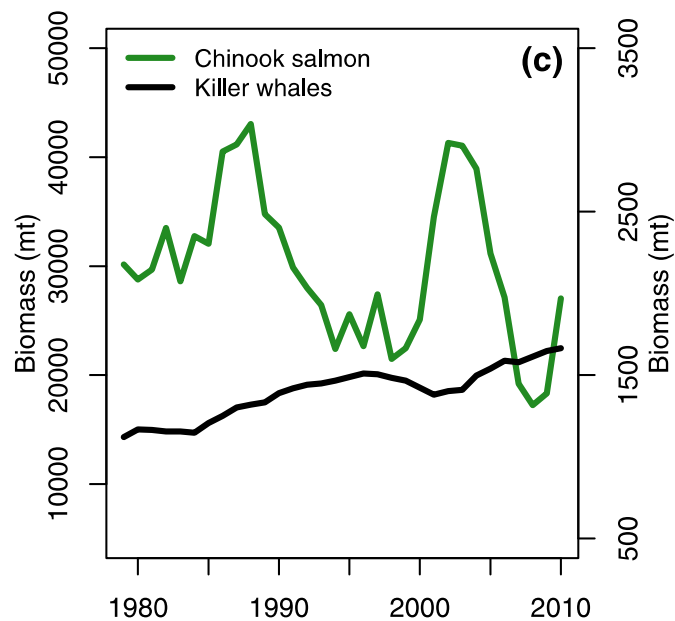
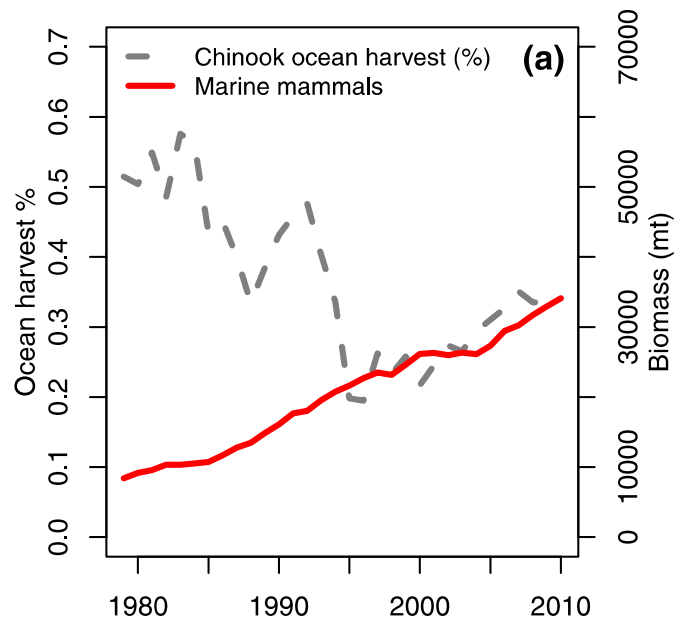
Is predation relatively small?



Or is predation much larger?



- Whether or not (and how much predation) is included affects our estimates of how many salmon are in the ocean



POLICY PERSPECTIVES

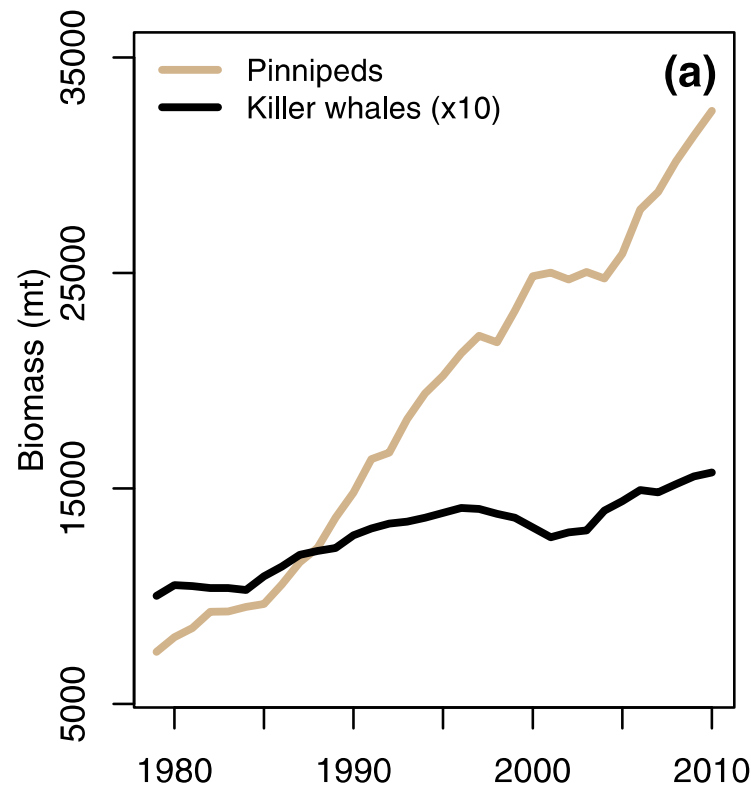
Conservation Challenges of Predator Recovery

Kristin N. Marshall¹, Adrian C. Stier³, Jameal F. Samhouri¹, Ryan P. Kelly², & Eric J. Ward¹

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Modeling salmon, fishing, whales and pinnipeds



Resident killer whale(CWR)



Harbor seal (WDFW)

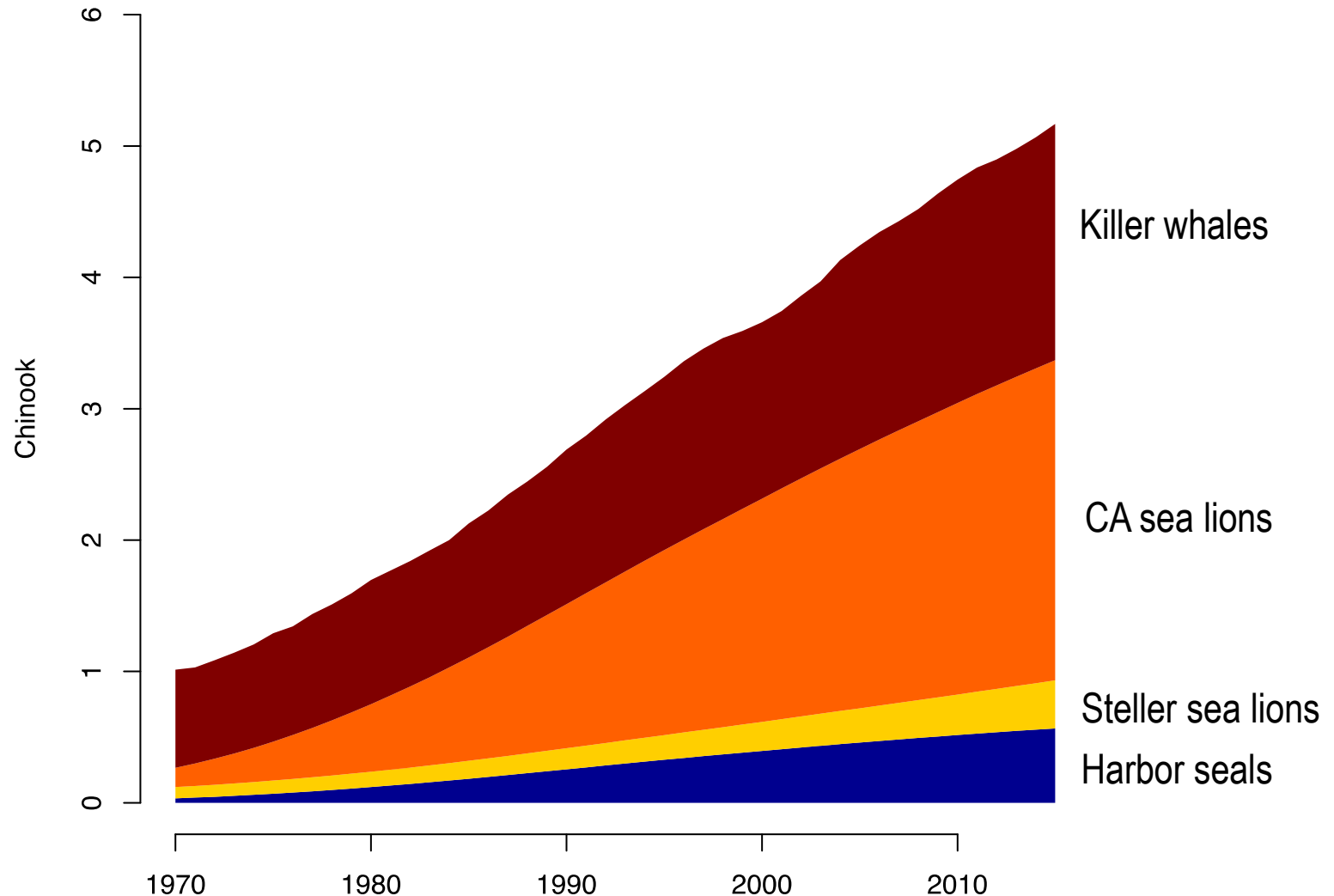


Chinook salmon (WDFW)



This food web is still very simple, but hopefully our models can be extended to other spp

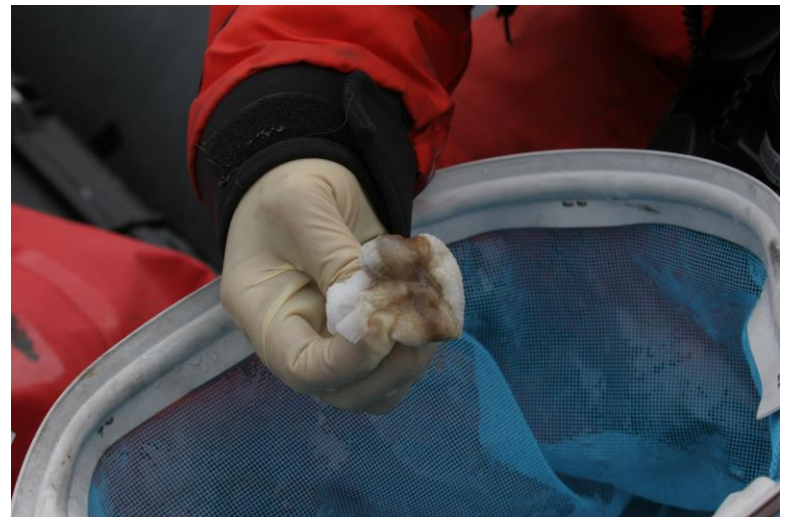
Shifting baselines of Chinook consumption: back of the envelope bioenergetics calculations



Research on threats

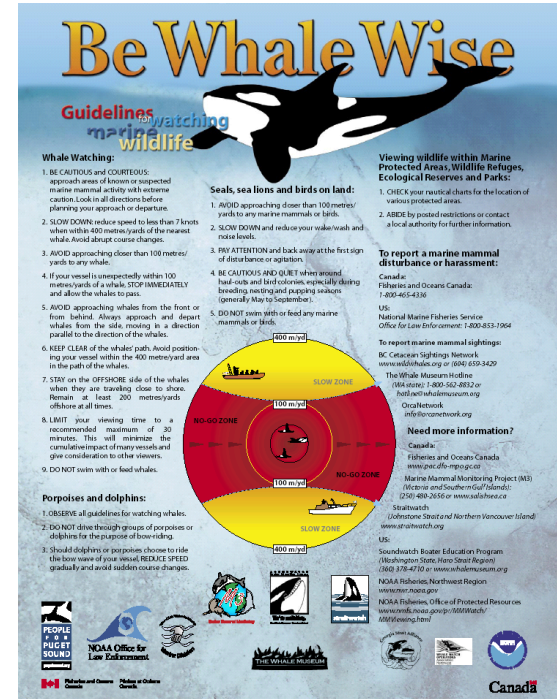
Distribution and diet

- Management and conservation issues
 - What is critical habitat?
 - Is there sufficient prey?
 - Which salmon stocks are most important?
- Methods
 - Satellite tagging
 - Acoustic monitoring
 - Observation/fieldwork
 - Diet studies



Quantifying effects of vessels and noise

- Management questions:
 - What are risks of increased vessel traffic?
 - Are current regulations effective?
 - Are additional regulations needed to reduce impacts?
- Science questions
 - Do vessels or noise change whale behavior?
 - Do changes in behavior affect population growth?

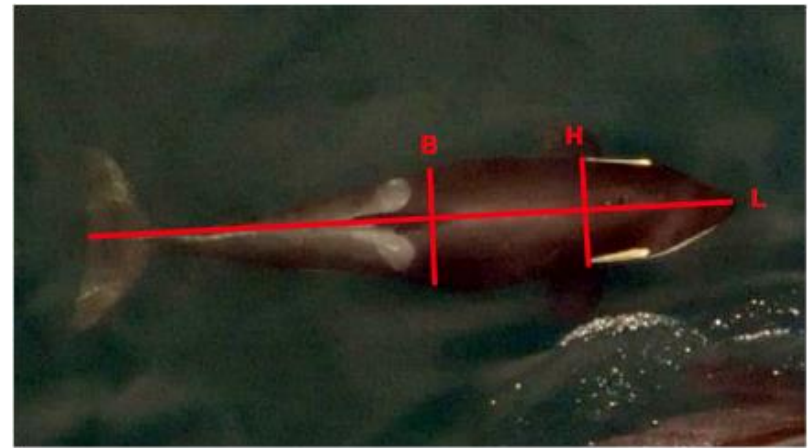


Assess health and condition trends

- Management questions
 - Nutrition status?
 - Contaminant loads, sources, effects?
- Methods
 - Biopsy analysis
 - Fecal hormone analysis (UW / Sam Wasser)
 - Photogrammetry (John Durban & Holly Fearnbach)



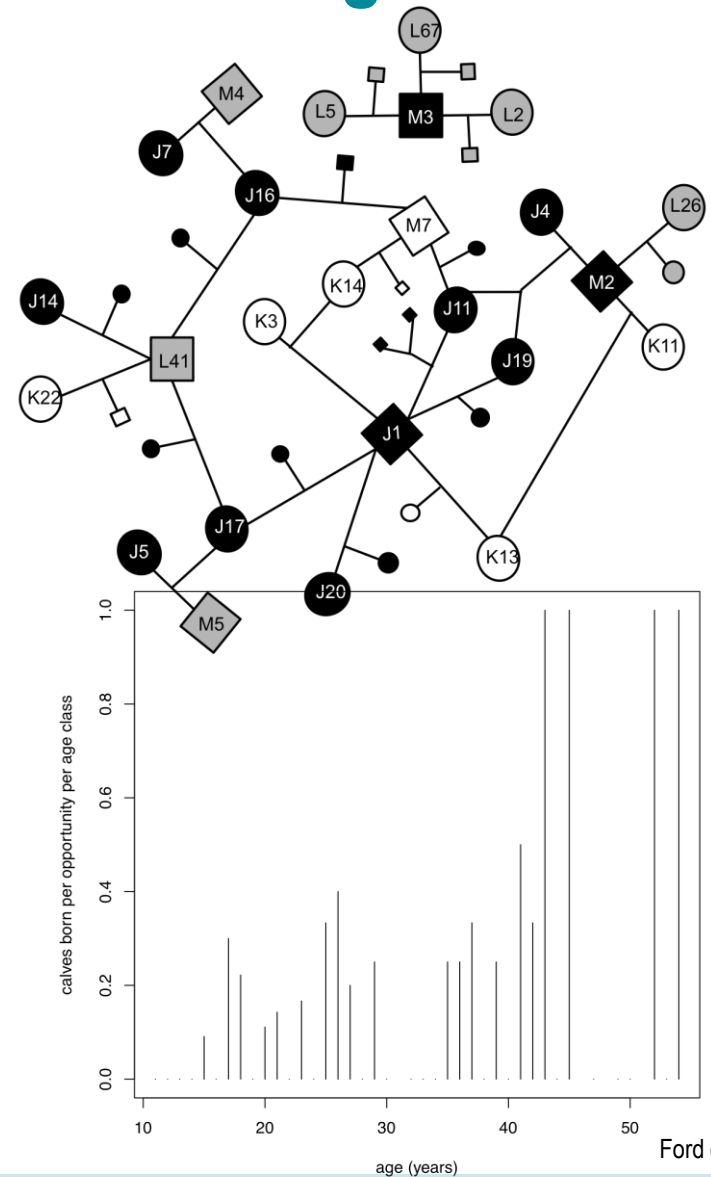
Ayres et al. 2012



Durban et al. 2009, Fearnbach et al. 2011

Estimate historical population size and genetic relationships

- Management questions:
 - Respond to ESA petitions (species question, DPS determination)
 - Recovery goals - historical size
 - Demography – mating structure
 - Cause of decline or limiting recovery– inbreeding
- Methods
 - Paternity analysis
 - Population genetics/genomics



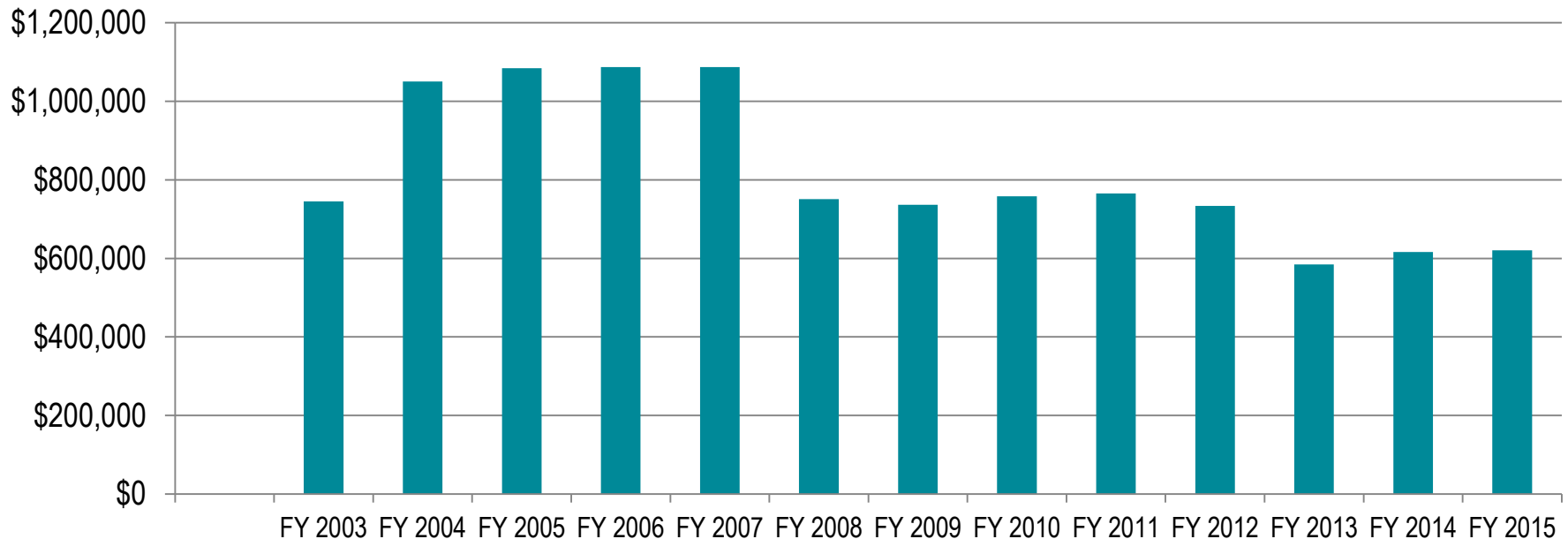
Ford et al. 2011

Strengths

- Focused, interdisciplinary approach
- Substantial progress in addressing uncertainties in recovery plan
- Strong connections with management
- Strong record of scientific productivity and publications

Challenges

- Stagnant NOAA funding



- Less for support for us, and also less support from other key parts of NOAA (e.g, OMAO, PMEL)

Understand and address factors limiting recovery of endangered Southern Resident killer whales

Examples of the science priorities not currently funded

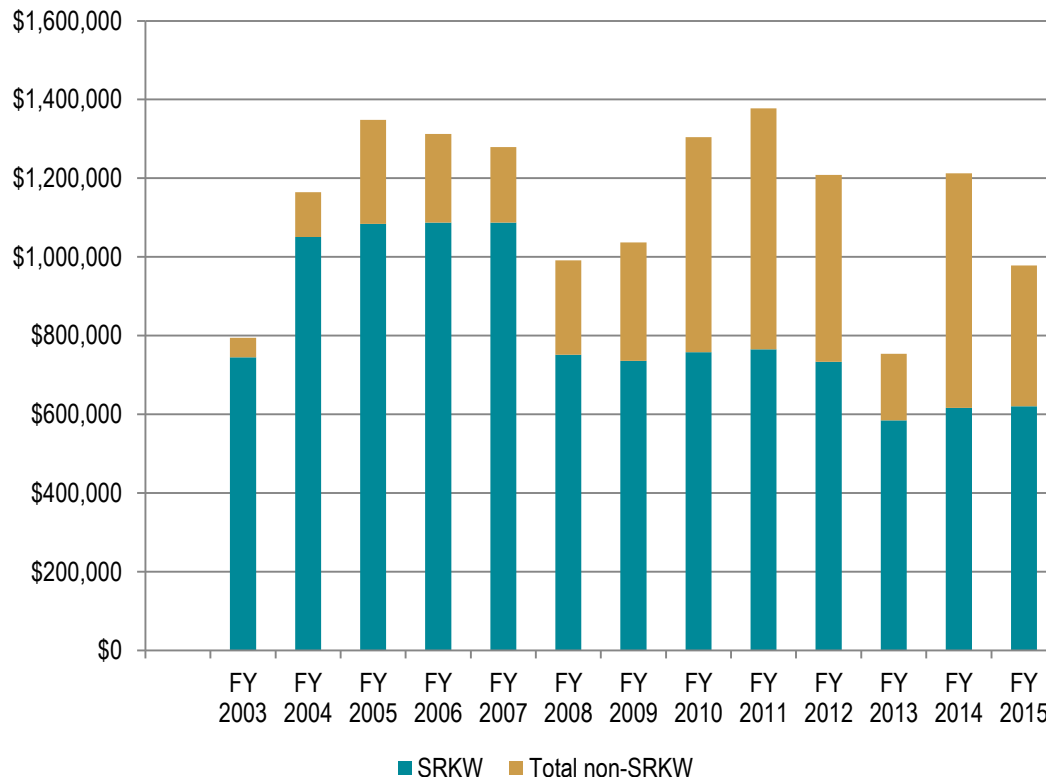
- Seasonal behavioral and field studies
- Seasonal health and condition
- Seasonal and stock-specific distribution of prey
- Laboratory/aquarium diet methods verification
- Continuation of contaminant, stable isotope and hormone analysis
- Immune system and microbiome studies

Challenges

- Better understanding of factors limiting recovery, but..
- Many are very hard to change
 - Salmon abundance
 - Competition with other predators
 - Legacy and new contaminants

Opportunities

- New funding sources
 - Navy
 - Office of Naval Research
 - Pacific Salmon Commission



Opportunities

- New technologies
 - UAV's
 - High throughput sequencing
 - Microbial genomics
- High profile – Species in the Spotlight
- Greater use of captive animals
- Build on connections to salmon recovery efforts

Thanks

